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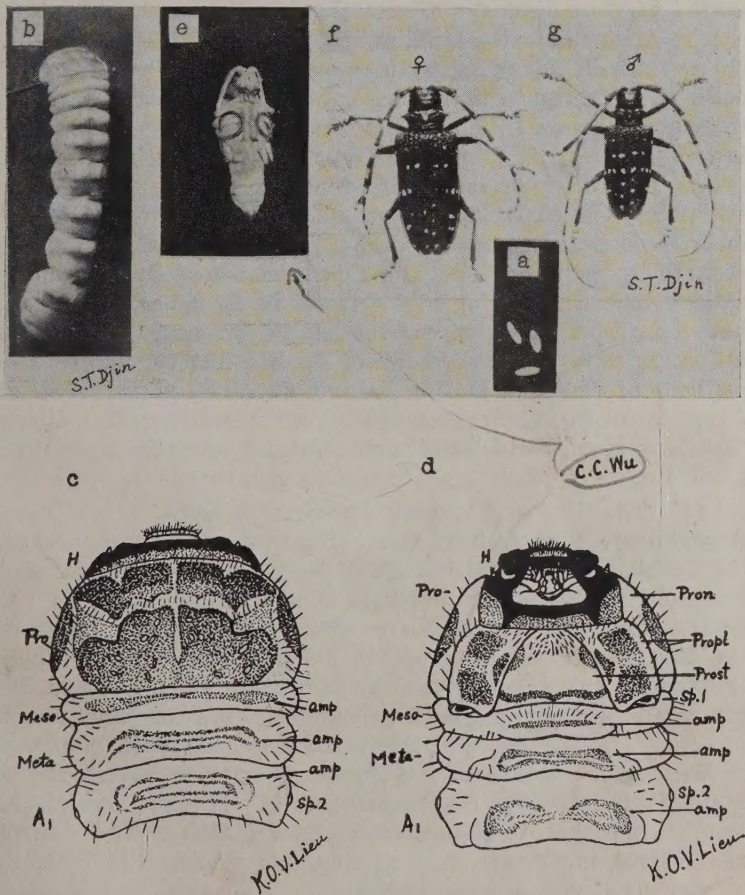

Fig. 1.—a, eggs; b, larva; c, dorsal view of head, thorax, and first abdominal segment of larva; d, ventral view of the same; e, pupa; f, adult, female; g, adult, male. (a, b, e, f, and g, all natural size; c and d, both times four.)

THE STUDY OF WOOD BORERS IN CHINA—I

Biology and Control of the Citrus-root-cerambycids, *Melanauster chinensis*, Forster (Coleoptera)

By K. O. VICTORIA LIEU*

INTRODUCTION

This study of the wood-borers has been conducted over a period of more than ten years. During this period about 60 species, belonging to ten families, including Aegeriidae, Cerambycidae, Curculionidae, Buprestidae and Bostrychidae have been collected from the roots, trunks or branches of some 16 species of trees. Whenever the material of any wood-borer was scanty, it was preserved as a specimen only. If sufficiently abundant, it was reared in the laboratory for study. The study of the life history and control of the wood-borers is much more difficult and time consuming than a similar study of a leaf feeding insect. The method of studying these wood-borers has been to make a tentative rearing of the insect in the laboratory to see how it may be kept alive and the length of its stages, followed by careful and thorough study of its life history, habits, and methods of control. During these ten years altogether about 20 species of wood-borers have been reared and studied. Among these, six species which are abundant and injurious have been studied more seriously and completely, namely:

(1) The Mulberry borer, *Paradoxecia pieli*, Lieu (Lep., Aegeriidae). Research on this borer was carried out, first in the Chekiang Provincial Bureau of Entomology, Hangchow and continued to completion in Musee Heude, Shanghai, where the writer was an Honorary Research Fellow. Before resigning from the Bureau, because of illness in June, 1934, she had studied the damage to mulberry trees by the larvae and developed the methods of rearing the larvae in artificial burrows and means of control. These have all been given in lectures to students in the training school of the Bureau where the writer was a lecturer concurrently. A description of the new species, in English and the preliminary notes on the biology and control of the same, in Chinese were written, and published in 1935.

(2) The Yellow-spotted Mulberry Cerambycid, *Psacothea*

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hilaria Pascoe. The reserach on this wood-borer was started in the Musee Heude, Shanghai, in the spring of 1936. On November 17th, due to our war of resistance in Shanghai, the writer left for the interior. After a very arduous journey from Shanghai to Chungking, she resumed the studies of wood-borers, although on a smaller scale. In 1938, the writer was granted a fellowship by the Board of Trustees for the Sino-British Boxer Indemnity Fund. Due to the scarcity of mulberry trees in Eastern Szechuen, this work was dropped temporarily. Since citrus fruit is one of the principal products of Szechuen, and since the damage done to the citrus trees by cerambycids is very serious, their study was suggested by Prof. K. S. Sie, Director of the National Agricultural Research Bureau and Prof. F. C. Woo, Entomologist and Plant Pathologist. A survey of Kiangtsing, one of the three centers of Szechuen, revealed the severity of the damage done to citrus trees by the cerambycids and the writer took up their study. This included the study of as many of the species of the citrus cerambycids as she could find.

(3) The Citrus-trunk Cerambycid, *Nadezhdiella cantori*, Hope. The study of this borer is now in manuscript in Chinese. A few simple and concise Chinese papers on this borer are awaiting revision for publication.

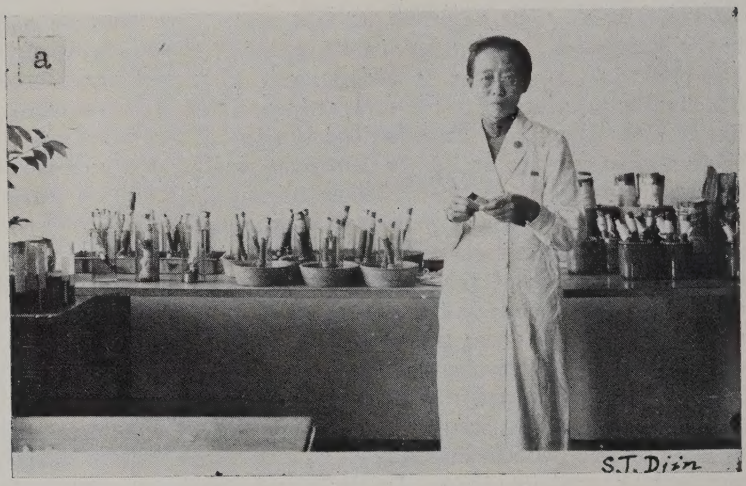
(4) The Citrus-branch Cerambycid, *Chelidonium* sp., probably new, likewise has been studied and a paper is awaiting revision for publication.

(5) The Apple-lateral Cerambycid, *Chreonoma dioica*, Fairmaire has been studied at the same time as the above and some concise papers on the insect have been published.

(6) The Citrus-root Cerambycid, *Melanauster chinensis*, Forster, one of the most serious of the citrus cerambycids is the subject of this paper. This species is cosmopolitan, and the adult has been described before. The systematic position of it according to "A Study of the Longicorn Beetles of Kwangtung Province, S. China (Coleoptera; Cerambycidae)" by J. L. Gressitt, is as follows: Family Cerambycidae; Sub-family Lamiinae; Tribe Monochamini; Genus Melanauster Thomson, 1868; Species Melanauster chinensis Forster.

BIOLOGY

This species of cerambycid, in both its larval and adult stages, very seriously attacks living citrus trees. In its larval stage, it makes burrows first under bark and later enters the


a
S.T. Dzin

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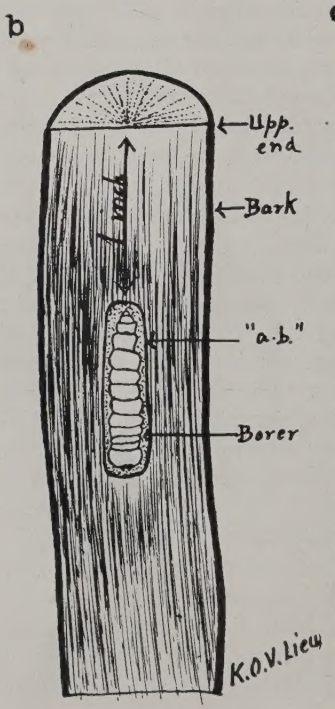
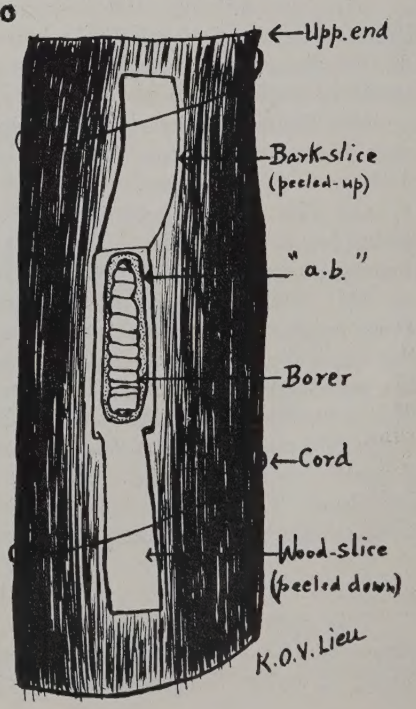

b
Upp. end
Bark
"a.b."
Borer
K.O.V. Liew


c
Upp. end
Bark-slice (peeled-up)
"a.b."
Borer
Cord
Wood-slice (peeled down)
K.O.V. Liew

woody tissues of the lowest portions of the trunks, the roots, and the rootlets. This method of attack is absolutely fatal to the trees. The uprooting of some citrus trees by strong winds at Kao-tien-tzu, Nan-nie-kuer, and some other places in Hwa-yang-hsien, and many at Wu-chiu-toe and Hsien-feng-chang of Kiang-tsing-hsien were all due to the work of this species of the borer larva. As an example: a citrus tree, *Citrus sinensis*, 20-30 years old, in Feng's orchard at Kao-tien-tzu, (text-figure 3 e), fell down as the result of a strong push, and two more trees of the species of *Citrus tangerina*, one about 5-6 years old (text-figure 3, b) and the other about 80 years old in Lai's orchard, at Nan-nie-kuer, died unnoticed in about one and five years, respectively. The adults damage citrus by eating the petioles of leaves and the bark of twigs and branches, and the trunks of young trees. Sprays of leaves are often seen to droop from being gnawed at the bases, and twigs, branches, and trunks of young citrus trees died and dry up from being deprived of their bark (text-figure 3, a & c; text-figure 4, e).

Due to the rigid conditions in finance and the difficulties in communication during our war of resistance, the writer has not had any opportunity to make a thorough survey in all citrus-growing districts of Szechuen; but is quite sure that the damage done to citrus by this species in Szechuen is equally serious wherever much citrus is grown. This is true not only in Szechuen, but also in other citrus-growing provinces, such as Kwang-tung, Kwang-si, Fukien, and Chekiang. This is evident from the fact that soon after the booklet, "*Melanauster chinensis*, Forster (Citrus-root-cerambycid)", was published in April, 1941, many letters asking for it were received. In spite of the difficulties in communication, up to the present, about eight hundred copies of it have been sent out to citrus growers of some twelve provinces.

Although our final object in studying an insect-pest is to discover methods of control, these cannot be carried out success-

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Fig. 2.—a, rearing of the larvae (wood-borers) in branch-segments, stood in water in glass jars, which are surrounded with water in earthen vessels, or shallow pans, in the laboratory. The writer is binding up a piece of branch segment after having examined the larva in it; b, the longitudinal section of the upper portion of a citrus-branch-segment, showing the "artificial burrow" ("a.b.") made for the borer; (times 1); and c, the lowest portion of the trunk of a citrus tree, showing the way of making an "a.b." in it, and the "colonization" of a borer in the "a.b." (times 1).

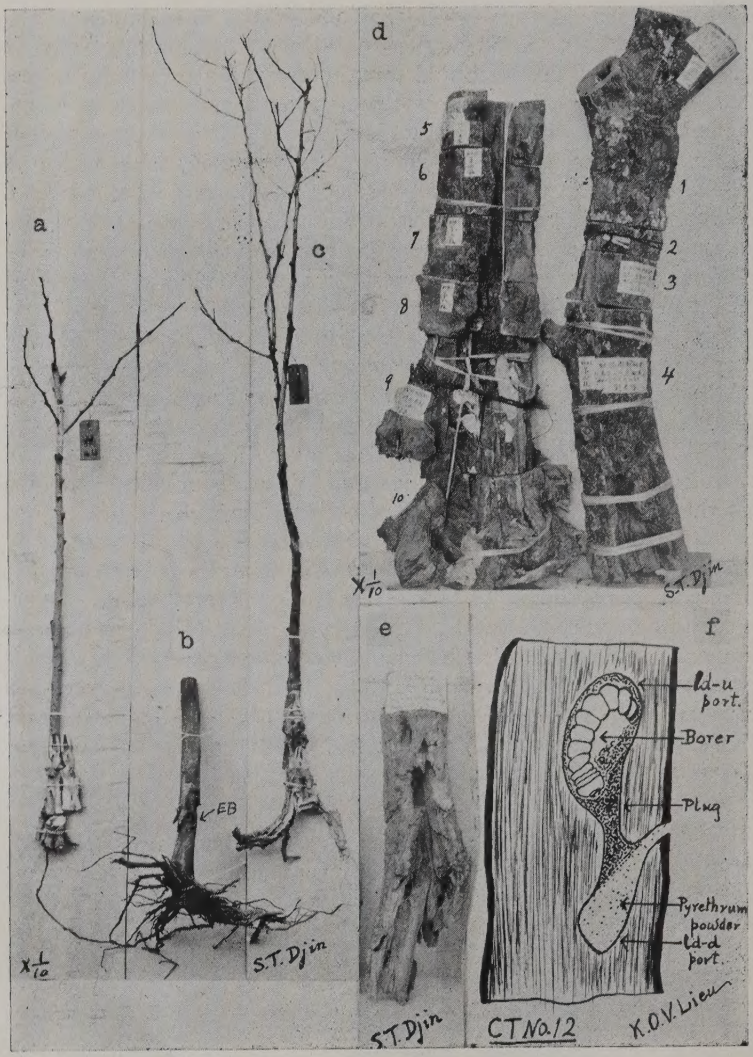

Fig. 3.—a, the young *Citrus tangerina* No. 66, 2-3 years old, about 3 feet high, showing the damage done to the root and the lowest portion of the trunk by the larvae, and to the bark of the trunk and branches by the adults; b, the root and the lowest portion of the trunk of a *Citrus tangerina*, 5-6 years old, from Lai's Orchard at Nan-niekuer, showing the broad and shallow burrow made in the wood immediately under the bark which had been detached, and the entrance-bore (EB) leading to the interior of the wood, made by one of the larvae; c, the young *Citrus tangerina* No. 63, 3-4

fully until the weak point or points in its life-history have been found. As a rule, the first step in handling such a problem must start from studying the life-history and habits.

In studying this species, many difficulties in collecting, in rearing and investigation were met.

DIFFICULTIES IN COLLECTING. Before the writer acquired a thorough knowledge of the life-history and habits of this species, the collecting of the larval material was a very difficult matter because they are wood-borers, and only 16-20 mm. long, and, throughout their existence, normally concealed, as are also their pupae and adults in their burrows in the woody tissues of the lowest portions of the trunks. They can be obtained only by chiselling, cutting, sawing, splitting, or even uprooting of a tree. Consequently, many difficulties had to be contended with, particularly in obtaining the permission from the owners of citrus orchards who, very often, did not allow their citrus trees to be touched with tools, especially during the period from the latter part of April, when citrus begins to bloom, to some time in December, when the fruits are ripe and ready for harvest. Between December and April, when the temperature is very low, most of the borers are still hibernating. To make the owners of citrus orchards understand the purpose required much effort. Besides, if a borer has already burrowed deeply into the trunk, or has burrowed downward into the root, it would be unwise and unreasonable to damage a tree, or even kill it, for simply getting one or two borers. Moreover, in chiselling and cutting, or in sawing and splitting, a borer is very apt to be injured by the tools. Therefore a whole day spent in collecting usually resulted in obtaining only a few borers, of which the living ones for rearing were still fewer.

METHOD OF STUDY. The most difficult period in rearing a cerambycid, which attacks living wood, is during its larval

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years old, about 4 feet high, showing the damage done to the root and the lowest portion of the trunk by the larvae and to the bark of the trunk and branches by the adults; d, the trunk and the root of an old *Citrus tangerina*, 70-80 years old, showing the combined damage by the larvae of this species and those of the citrus-trunk-cerambycids (*N. cantori*, Hops); e, the root and the lowest portion of the trunk of a *Citrus tangerina* from Feng's Orchard at Kao-tien-tzu, showing the damage done by the larvae; and f, the longitudinal section of a lemon branch (CT No. 12), branching from the short trunk of a lemon tree at a very low point, showing a larva hibernating in the upper portion of its burrow, with a "plug" of wood chips below its head for protection—(times 1).

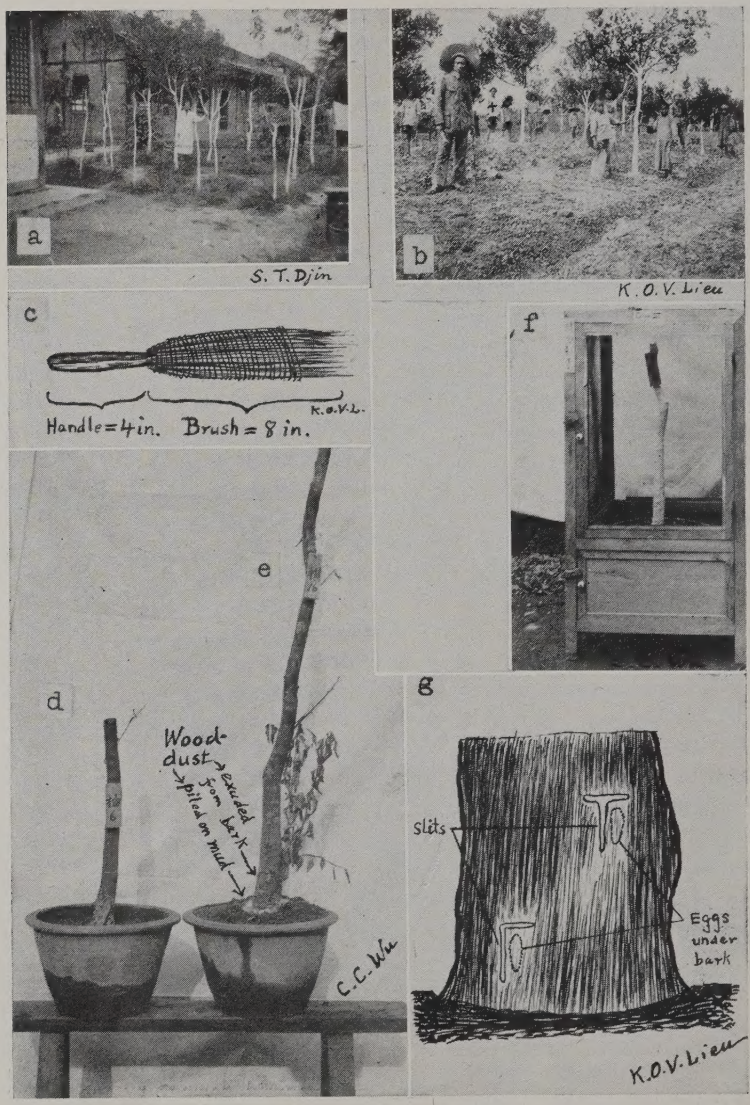

Fig. 4.—a, whitewashing of the citrus trees for control tests against both this species and the citrus-trunk-cerambycids (McH), with the writer standing among her trees inside the college; b, whitewashing of the citrus trees in the Lion-hill orchard of this college, for the same purpose, taken immediately after the work is done; c, the home-made brush for applying the whitewash paste on trees; d, the young *Citrus grandis* No. 6, about 5

stages, because this stage of a cerambycid usually lasts very long, from several months to 3 or 4 years.

In the laboratory, whenever a cerambycid larva (borer) of any species is collected, it is first examined with a hand lens to see if there is any parasitic egg or larva on its boy. Then, it is "colonized" in an "artificial burrow" in a segment of a branch.

From experience in studying the wood-borers, *Paradoxecia pieli* (a mulberry Aegeriid), *Psacothea hilaria* (a mulberry Cerambycid), and some other cerambycids, the writer has devised, after many trials, a very successful method of rearing them, i.e., "colonization" of wood-borers in "artificial burrows", which method she is employing for rearing the borers of this species of citrus cerambycid.

In rearing, the borers of each species collected are divided into two groups, one group is "colonized" in branch-segments in the laboratory, and the other "colonized" in thick branches or trunks of trees in the field. The methods of "colonizing" a borer in a branch-segment and in the trunk of a citrus tree consists of six steps:

1. Split a segment of a branch, about 20 cm. long and thick enough to contain the borer, longitudinally into two halves of unequal size;
2. On the surface of the longitudinal section of the larger half with a sharp chisel, cut the 4 sides of a rectangle, whose upper side is about 1 in. from the upper end of the segment, and pare off the woody tissues of the rectangle to make a burrow, just big enough to contain the borer to be colonized (see text-figure 2, b). Thus, an "artificial burrow" ("a.b.") is finished;
3. Place the borer, head-up or head-down, according to its original position, in the "a.b.";
4. Fit the smaller half of the branch-segment upon this larger one, and bind them together against the "a.b." with a white ribbon;
5. Apply a label, with the number of the borer and the date of "colonization", on the bark of the smaller half of the segment just a little above the ribbon; and
6. Finally stand the segment in a little water in a glass jar, which is

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years old, removed from the cage to show the damage done to the lowest portion of the trunk by the larvae, hatched from the eggs deposited there by the females in the cage; e, the young *Citrus sinensis* No. 16, 6-7 years old, removed from the cage to show the damage done by the larvae and adults while inside the cage; f, the young *Citrus tangerina* No. 10, 4-5 years old, whitewashed and placed inside the cage for studying control test; and g, the lowest portion of a citrus trunk, showing the slits made by the female adults and the eggs deposited under the bark—(times 1).

again stood in a shallow earthenware vessel of water (see text-figure 2, a), and record it in the record-book for this species.

To "colonize" a borer (say about 20 mm. long) in the trunk of a living tree consists of eight steps:

1. Choose a healthy citrus tree, and apply a wood label with a number, such as *Citrus tangerina* No. 5;
2. Chose a position on the lowest portion of the trunk, a few inches above the ground. On the bark here, cut the right, left, and lower sides of a rectangle, about 25 mm. long and 8 mm. wide, and peel this slice of bark up, and fasten it against the trunk with a cord;
3. On the cambium layer of the trunk at this place, cut the right, left and upper sides of a rectangle, a little shorter and narrower than the first one, and peel the thin slice of woody tissues down, and fasten it, also against the trunk;
4. Then, carve a still shorter and narrower rectangle at the same place, and pare off the woody tissues of this rectangle to make a burrow, just big enough to contain the borer to be "colonized". Thus, an "artificial burrow" ("a.b.") in the trunk is finished (see text-figure 2, c);
5. Place the borer in its original position, in the "a.b.";
6. Raise the slice of wood into position, and lower the slice of bark down as well;
7. Wrap this part of the trunk with a piece of oil-paper or glossy-paper, and wrap it with layers of bark-fibers of Chinese hemp (treated) to prevent the drying of the "a.b.", the entrance of rains, and the attacks of ants;
8. Finally, record it in the record-book on "Colonization of Wood-borers in Citrus trees."

The borers "colonized" in the segments of branch need much more care, work, and time than those "colonized" in the trees; because the segments of branches, though standing partly in water, still tend to become dry and have to be replaced with fresh ones frequently; how often depending on the weather, and the condition of the borers.

As soon as a larva has burrowed to the lower end of a segment, or the segment has become dry, it must be replaced.

Furthermore, to protect the borers from being attacked by a species of small red ant (a *Monomorium* sp. as determined by Dr. M. R. Smith), the whole segment is stood in water.

DIFFICULTIES IN INVESTIGATIONS. The branch must be examined every day or two, (1) to observe the presence of any wood-dust or frass and (2) or any new boring done and these observations are recorded. Then, the segment is untied, opened, and examined, and the following points noted and recorded, (1) the appearance of the borer, (2) in what direction its head

points, (3) how it burrows, (4) how long it has burrowed, (5) how many burrows it has made, (6) the length of its body, (7) whether there is any "plug" made, (8) whether there is any exuviae or parts of exuviae, etc. Before the halves of the branch-segments are closed up the inside is cleaned and wiped with a dry towel to prevent any interference by factors from outside, the glass jars and earthenwares cleaned, and the water in them changed.

Although the borers "colonized" in trees are not so troublesome as those "colonized" in segments of branches, they have to be observed and recorded every day.

From these investigations, the growth, moltings, habits, hibernation, transformation, damage done to the interior of the wood, and the methods the borers use for self-protection can be studied. From the investigation of the borers "colonized" in trees, the actual lengths of the larval, pupal, and adult stages, the periods of hibernation and transformation, and all the phenomena and habits connected with these can be studied with exactness.

As to the adults, pairs of males and females are reared in big wire cages supplied with young citrus trees planted in pots for food, where oviposition, habits, injury, etc., can be studied, for about two years.

A. MORPHOLOGY

1. THE EGG. The egg (text-figure 1, a) is elongate, subcylindrical, and tapering towards both ends, varying very slightly in form. The surface of the eggshell is smooth. The color, when first deposited under bark, is creamy-white; but towards hatching gradually turns yellowish-brown. The average of 20 eggs was 5.5 mm. when measured, and the average diameter across the middle 1.7 mm.

2. THE LARVA. The larva (figure 1, b) is a legless grub, about 5 mm. long when first hatched, and the largest ones are about 52 mm. long when full grown, measured from the anterior margin of the prothorax to the tip of the abdomen. Its color is creamy white except some yellow, chitinized patterns on the prothorax.

The head is dull yellow brown in the anterior half, and chestnut brown near the oral margin. It is moderately depressed with the sides parallel. The antennae are very short, and consist of three segments each. The ocelli, one on each side, are

ventro-lateral to the antennae. The mandibles are black, and are very strong cutting tools. The labial palpi are two-jointed; and the maxillary palpi three-jointed.

The width of the prothorax is about twice that of the head; and its length about one and one-half times that of the meso- and meta-thorax combined. The yellow chitinized patterns on the dorsal, ventral, and lateral sides of the prothorax, and the ampullae on the dorsal and ventral sides of the meso- and meta-thorax and the first abdominal segment, as shown in the text-figure 1, c and d, are probably characteristics of these species, or at least of the genus.

The abdomen consists of ten segments, which are nearly equal in width, but slightly constricted between the 6th, and 7th segments. The segments vary in length. The 1st and 2nd are very short; segments 3 to 8 are each about twice the length of the 1st, or the 2nd; segment 6 is the longest and 10 one of the shortest. The larva has 9 pairs of spiracles. The first pair is located on the sides of the prothorax, also visible on the ventral side; and the remaining pairs are on the sides of 1-8. The ampullae on the dorsal and ventral sides of abdominal segments 1-7 are similar to those of the first abdominal segment as shown in the text-figure 1, c and d.

3. THE PUPA. The Pupa (figure 1, e) varies from 27 mm. to 38 mm. in length. The head is large with the front directed obliquely inward below, with the labial and maxillary palpi, directed caudad, almost parallel to the axis of the body. The elytra only partially cover the wings; both are curved around to the ventral surface of the body. Ventrally the tips of the elytra approach each other more than those of the wings; they do not meet but leave a space for the tarsi. The wings actually lie against the sides of the body, with the tips pointing posteriorly. The pro- and meso-thoracic legs are sharply bent at the femoro-tibial joints of the pro- and meso-thoracic legs, and then coil ventrally to lie over the elytra and wings.

The first pair of spiracles, located on each side between the pro- and meso-thorax are also visible from the ventral side. The abdominal spiracles 1-5 are conspicuous on the sides, while the remaining 3 pairs are degenerate.

At the tip of the abdomen, there is a chitinized process, which is curved dorsally to form a V, when viewed from the caudal end with the ventral side up. Considering the absence of this process from the pupae of several other species of Cerambycids,

it is most probably an important characteristic of this species.

On the dorsal side of each abdominal segment 1-4, there are two groups of thick setae, one on each side of the segment; they are used for locomotion.

4. THE ADULT. The adult is large and stout; shining black with somewhat rounded spots of white pubescence on the elytra. The two sexes (see text-figure 1, f and g) are very similar, differing only in size, in the length of antennae, and in the structure of genitalia. The body length of males is 22-38 mm., and that of the females 24-40 mm. The width of males across the bases of elytra is 9.5-11.5 mm., and that of females 11.0-13.8 mm. The head is vertical. The antennae are very long in both sexes. They consist of 11 segments each, and are setaceous in form. In males, the distal end of the 6th segment reaches to, or a little beyond the tip of the abdomen; while in females, to the distal end of the 8th segment does so. The tip of the abdomen of the males is entirely covered by the elytra, while that in females is more or less exposed. Since this species is not new, no further description of the adult is necessary.

B. LIFE HISTORY

While the writer was waiting in Chungking for a location for research to be arranged by the Board of Trustees, she went on with her study of the termites and the mulberry cerambycid (an *Apriona* sp.). When, on January 12, 1939, a notice was received informing her of the location she started early next morning for Chengtu, and arrived at this college on January 17.

Usually, to make a study of an insect pest, one should start in the late spring or summer, when most material is available. Since January and February are the coldest months of a year in Chengtu, neither appearance of the adults nor activities of the larvae of any cerambycids can be expected. The anxiety for material urged the writer to make early explorations into the citrus districts in the suburbs of Hwa-yang-hsien, such as Dong-chia-shan, Kao-tien-tzu, Lion Hill, etc., for damaged trees, with the hope of getting some larvae, pupae, or hibernating adults of some cerambycids by sawing and splitting the branches, trunks, and roots of the trees and of getting some idea of how a cerambycid borer enters the trunks and roots, how it lives and prepares for its emergence, and how the wood inside is actually damaged. The first collecting trip made was to Dong-chia-shan on January 29, and was followed by several others

in February. The results obtained at first were rather disappointing. After having made several trials, she was able to find in an orchard at Dong-chia-shan, a very large dying citrus tree between 70-80 years old, and after much explanation and persuasion to obtain it from the owner on March 1, 1939 (see text-figure 3, d).

This large tree was a *Citrus tangerina*. Its main root (9 and 10 in the figure) was at a depth of about a foot and a half. It trunk, 6-8 inches in diameter (1-8 in the figure), was about 5 feet high, with three thick branches ranging from 8 to 10 feet long. The root and the trunk had been badly burrowed by the larvae of this species and the larvae of the citrus-trunk cerambycids, *Nadezhdiella cantori*, as proved later through rearing. The tree was almost dead, having only a few smaller branches bearing some old leaves of the previous year. The poor appearance of the root and trunk of the tree, as shown in the text-figure 3, d, may well represent the general condition of citrus trees damaged by the larvae of the two species of cerambycids at Wu-chiu-toe and Shien-feng-chang of Kiang-tsing-hsien, Chao-chia-tu of Kin-tan-ksien, and all citrus-growing districts of Hwa-yang-hsien, which the writer has visited.

After this dying tree had been brought back to the laboratory, with the help of the late faithful workman, Wang-soo-yuin, its branches were sawed into many segments, and the root together with the trunk was sawed into ten portions and later split into many pieces. The root, the trunk, the branches, and the twigs were thoroughly and carefully re-split into many smaller pieces and examined. Since this tree was dying, it had of course, been deserted by most insects, except a few species of wood-borers, which might have entered it some months or years before. These were:

(1) A larva of this species found in the root; (2) a hibernating adult of *Nacezadiella cantori* in its pupal-cell in a thick branch; (3) a larva of the citrus-branch cerambycid, *Chelidonium* sp., in a thick branch; (4) a few buprestid larvae under the bark of the trunk; (5) a few red-banded larvae of cossidae (?) in branches; (6) a few small creamy-white larvae of cossidae (?) in smaller branches; and (7) some cicada's eggs in the few living twigs. These larvae and the hibernating adult were either reared or preserved, and the affected parts kept as specimens. The entire examination of this big tree required more than two weeks.

Though the time spent in examining this big citrus tree seemed great and the insects obtained few; from the point of view of research, what was obtained from it was really of much importance, because at the beginning of her research with the different species of citrus cerambycids, everything was unknown to the writer and she obtained some information which helped her much in collecting and studying these species.

Before one has acquired a thorough knowledge of the life history and habits of this species, the collecting of its larvae is very difficult. *Therefore, the study of this species began from collecting the adults in May and June, 1939.*

Since the larval stage of this species (*Melanauster chinensis*, Forster), is the most diffcult to be reared of all the species of cerambycids studied during the past nine years, the study of its life history has been repeated twice, first in the year 1939-40, and again in the year, 1940-41.

THE STUDY OF THE LIFE HISTORY OF *Melanauster chinensis*, Forster in 1939-40. From May 28 to June 26, 1939, ten adults were collected from citrus trees. Of these only two were males.

The first one collected on May 28, 1939, was a male. It was reared in a big glass jar, covered with a board, and supplied with a segment of a branch and a spray of leaves for testing its food habits. The second adult, collected on June 6, was a female, which was immediately mated with the first male in the glass jar and the segment of a branch and the spray of leaves were replaced with fresh ones. The beetles were seen to eat the leaves, petioles, and the bark of the spray and the segment of the branch. Two days later, the segment was examined, and two T-shaped incisions were found on the bark near the lower end of the segment, and two eggs were found under the bark. one at each incision.

On June 8, the two adults were transferred to a large wire-gauzed cage, and supplied with a young citrus tree planted in an earthen pot and a few sprays of leaves for the purpose of studying their food habits, mating, egg depositing, the damage inflicted, etc. This small tree was a *Citrus tangerina*, 2-3 years old, about 3 feet high and with a trunk diameter of about 0.6 inch (see text-figure 3, a). Between June 8 and 13, three incisions were found on the bark at the basal portion of the trunk.

Since this tree was very small, it was removed from the cage, and another small one supplied. But, no more incisions were found.

On June 13, a second male and a second female were collected. They were treated in the same manner as the first pair on another *Citrus tangerina*, 3 or 4 years old, about 4 feet high and with a trunk diameter of about 0.8 inch (text-figure 3, c). Since the first object was to get as many eggs as possible, the four females, collected on June 16 and 24, were all reared in the same cage with the only remaining male. On June 20, this small tree was examined and seven incisions were found in the bark at the lowest portion of the trunk. This tree was removed, and three small trees were used in succession. In addition, eight segments of a branch were added in the cage in succession. Between June 13 and July 7, 13 incisions were made on the tree trunks and the segments.

The exudation of very fine wood dust and fibers indicated the hatching of the eggs. Since the trees were dying, it was feared that they mould be insufficient for keeping the larvae alive. Therefore, the trees were uprooted, sawed, and split, as were also the segments. Sixteen larvae were picked out of the trees and segments between October 6 and 15. Of these 16 larvae, 4 injured and 1 good one were preserved as specimens, 5 were "colonized" in segments of branches and 6 were "colonized" in trees. The segments and the 6 young trees with the larvae were all kept under observation in the author's laboratory.

The 5 larvae in segments died in from two weeks to 4 months. Of the 6 larvae, "colonized" in small trees, 2 died and 4 succeeded in transforming into adults, 3 males and 1 female. One adult emerged on June 8, others on June 25 and June 29, showing that this species has but one generation a year.

THE STUDY OF THE LIFE HISTORY IN 1940-41. The male adult emerged at about 6 a.m., June 8, 1940, from an almost circular bore, whose diameter was about 10 mm. made on the trunk of a *Citrus tangerina* at about 10 inches above the ground, and was caught inside the wire sheath wrapped around the tree trunk from May 20. It was taken out and liberated in a small wire-gauzed cage and fed with a segment of a branch bearing a few sprays of leaves. It ate the leaves, petioles, and bark. The female emerged between 1:10-2:02 p. m. on the same day, from a circular bore, whose diameter was about 9 mm. made on the trunk of the *Citrus tangerina* at about 10½ inches above the ground, and was caught inside the wire sheath as in the case of the male. These two adults were immediately mated

in a large wire-gauzed cage, supplied with a small tree, plus 1 or 2 sprays of leaves every day (for food).

Between June 8 and June 16, one or two matings were noticed every day and sometimes three matings a day, but not a single oviposition was made by the female. Both the male and the female gnawed at the leaves, petioles, and bark of the trunk so often that the small tree was entirely deprived of its bark and leaves. The adults sipped water from the wet mud in the pot.

Another small tree of *Citrus grandis* (text-figure 4, d) was placed in the cage on June 16. When it was examined on June 19, 3 incisions were found at the basal portion of the trunk. This was removed from the cage and a third tree of *Citrus tangerina* was again substituted. Although matings were seen nearly every day from June 16 to July 5, only 3 ovipositions were made by the female on the last tree before her death on July 6, 1940.

Six ovipositions were made on the two trees (*C. gandis* and *C. tangerina*) and two full-sized eggs were left in the female's abdomen after death. Therefore, the total number of eggs this female could have produced was 8. None were lost because as soon as the female had emerged she was kept in a wire-gauzed cage.

The length of the 4 matings observed in this cage were 38, 46, 55, and 70 minutes. This species does not deposit eggs soon after mating. The pre-oviposition period is rather long, and may take 1-2 weeks. Although many matings had been seen, only one oviposition was observed.

OVIPOSITION. On June 26, 1940, at about 6 a. m. this female cut the bark with its mandibles at the base of the trunk of the tree, *Citrus tangerina*, first vertically and later horizontally, to make a T-shaped slit, at about 2 inches above the mud. This took about 6 minutes. After the slit had been made, she turned her head upward and inserted the ovipositor into this slit, applying force for some 38 minutes, depositing one white egg in a vertical position under the bark (figure 4, g).

This female died on July 6, and the male on July 8, giving 28 days for the life of the female and 31 days for that of the male.

Besides this pair of reared adults, another 10 pairs, collected from citrus orchards in the suburbs of Hwa-yang-hsien in June and July, 1940, were kept separately in several large wire-

gauzed cages for studying food habits, mating, oviposition, incubation, fecundity, longevity, damage inflicted, host plants, control tests, and so on.

Of these 10 pairs, 6 pairs were studied in citrus trees without whitewash and 4 pairs tested in whitewashed citrus trees. The general plan for study and tests and the results obtained therefrom are tabulated in Table 1.

(ABBREVIATIONS USED IN THE TABLE: Wwed—whitewashed; Mulb. tree—mulberry tree; incis.—incisions; *C. tang.*—Citrus tangerina; *C. grand.*—Citrus grandis; *C. sinen.*—Citrus sinensis; segt.—segment; seedl.—seedling; C. spray.—Citrus sprayed; D.—Diameter of trunk; ext.—extension.)

DISCUSSIONS:

(1) The number of eggs deposited in C. sinensis was 8. This tree was not split, but left standing intact in the laboratory. Although all the 8 eggs hatched, only one larva was secured from under the bark and "colonized" in a small citrus tree about 3 years old, and the remaining larvae were left untouched. On May 30, 1941, a male adult, body length 22 mm., was caught in a wire sheath which had been applied on the trunk some 10 days before. It was killed and preserved as a specimen. The emergence of this adult again shows that this species of citrus-root cerambycid, *Melanauster chinensis*, Forster, has but one generation a year.

This tree was broken at the basal portion of its trunk by a slight touch by a small boy one day in September, 1941. When it was examined, it was found that:

(i) A broad and shallow half-formed gallery made by the larvae on the outside, extended upward from the base of the trunk, for about 10 inches (or 250 mm.);

(ii) A burrow, in the center of the trunk extended upward from the base about 3.2 inches (or 80 mm.);

(iii) Five or 6 partly connected shorter burrows, viewed from the under-surface of the basal portion of the trunk;

(iv) Five or 6, partly connected short burrows in the root, connected with those in the basal portion of the trunk;

(v) The root with the rootlets, about 6 inches (or 150 mm.) long, had also been severely burrowed;

(vi) A single big, circular emergence hole;

(vii) That no more larva, pupa, or adult were found in the tree proves very well that some of the larvae hatched

TABLE 1.—Showing the Results Obtained from Rearing Adults in Cages.

Adults in Pairs	Dates of mating and Death of Female (1940)	Tree or Segment Used	No. of Incis.	Egg Deposition (1940)	Larvae Hatched (1940)	Other Remarks
First pair	June 6—July 2	*C. tang.*	0			
		C. sinen (see text-figure 4, 2)	2	June 10-15	(1) June 21 (1) June 24	This tree not split; only one male adult
			2	June 10-24	(1) June 28 (1) June 29	emerged from a bore at base of trunk on
			4	June 24—July 2	(1) June 29 (2) July 30 (1) July 5	May 30, 1941. Adult preserved.
		Mulb. tree	0			Leaves not eaten.
		C. spray, daily				Leaves and bark, eaten
Second pair	June 8—July 12	*C. tang.*	3	June 16-19	(3) July 1-3	
			1	June 23	(1) July 2	
			2	June 25-27	(2) July 3-5	
		Cit. seg.	1	July 3	(1) July 9	
			5	July 5-8	(5) when?	2 killed
		C. segt. (Wwed.)	0			No eating
		Mulb. seedl.	0			No eating
		C. spray, daily				Leaves and bark, eaten
Third pair	June 13—July 23	C. segt.	1	June 20	(1) when?	Given away for ext.
		C. sinensis	2	June 29—July 10	(2) July 25-31	
		mulb. segt.	0			No eating
		C. spray, daily				Leaves and bark, eaten
Fourth pair	June 14—July 6	*C. sinen*	0			This tree, very poor
		C. spray, daily				Leaves and bark, eaten

TABLE 1.—SHOWING THE RESULTS OBTAINED FROM REARING ADULTS IN CAGES.—(Concluded.)

Adults in Pairs	Dates of mating and Death of Female (1940)	Tree or Segment Used	No. of Incis.	Egg Deposition (1940)	Larvae Hatched (1940)	Other Remarks
Fifth pair	June 14—July 3	*C. grand* (Wwed. 20 in.)	0			Trunk, 2 ft. high; D., 2 in.
			3	July 1-3	(1) July 26 (1) July 27 (killed)	The 3 eggs, deposited at places where lime washed away by rains.
		C. segt.	3	June 20—July 2	(1) never hatched	
		C. spray, daily				Leaves and bark, eaten
Sixth and Seventh pairs	July 2—Aug. 4	*C. sinen* (Wwed. 20 in.)	0			Trunk, 38 in. high; D., 2 in.
		C. segt., a.	3	July 19-27	(3) when?	3 preserved
		C. segt., b	1	July 19-27	(1) when?	1 given away (ext.)
		C. tang. (Wwed. 18 in.) (see text-figure 4, f)	0			Trunk, 24 in. high; D., 2 in.
		C. segt. c,	3	July 27—Aug. 2		
		C. segt. d,	2	ditto		
		C. segt. e.	6	ditto		3 killed
		C. spray, daily				Leaves and bark, eaten
Eighth pair	June 30—Aug. 5	*C. tang.* (Wwed. 8 in.)	0			Trunk, 24 in. high; D., 2 in.
		willow segt. a,	1	Aug. 2-4	(1) Aug. 11	No eating
		mulb. segt.	3	Aug. 2-4	(3) when?	No eating
		C. segt.	0			
		willow segt. b,	1	Aug. 3-4	(1) never hatched	No eating
		C. grand.	1	Aug. 4	(1) Aug. 15	
		C. spray, daily				Leaves and bark, eaten
Ninth pair	June 30—July 28	*C. grand.*	0			
		C. spray, daily				Leaves and bark, eaten
Tenth pair	July 28-30	*C. sinen*	4	July 28-30	(1) Aug. 14 (3) when?	
		C. spray, daily				Leaves and bark, eaten

N.B.—The citrus trees used in the cages were either 4-5 years or 6-7 years old. and their tops cut off in order to be placed in cages.

must have been killed by other larvae while others must have been eaten by ants; and

(viii) The damaged condition of the tree shows that it must have died since the previous winter.

(2) Sixteen eggs were deposited in citrus trees (excluding *C. sinen.* No. 16) 16
Twenty-five eggs were deposited in C. segments..... 25
Two eggs were deposited in willow segments..... 2
Three eggs were deposited in mulberry segments.... 3

(3) Of these 46 eggs laid by the 9 females, 5 failed to hatch, 6 were destroyed during splitting, 2 were given away for extension work and 3 larvae were preserved, leaving 30.

In addition 1 larva was picked out from *C. sinensis,* 3 from *C. grand.* and 3 from *C. tang.,* making a total of 37 larvae to be colonized for study.

(4) The adults do not deposit eggs in citrus trees in poor condition, as in the case of the female of the fourth pair, though it had 16 eggs in its abdomen.

(5) The adults, while confined in the breeding cage, ate the leaves, petioles and bark of citrus trees, but never those of either willows or of mulberries.

(6) The adults never deposited eggs in the whitewashed segments of citrus trees in the cage of the second pair, nor in the whitewashed citrus trees in the 2 cages of the sixth and seventh pairs and of the eighth pair. One female did deposit 3 eggs in a whitewashed *C. grandis,* but only at places where the whitewash had been washed away by heavy rains, which occurred almost every day from June 27 to July 1, 1940. For the compositions of the whitewash used in the different tests and the detailed discussions of the results see—under heading "Control".

Colonization of Larvae in Trees and Branch-Segments in the summer of 1940. Of the 37 larvae to be colonized for study, the group (A) of 15 larvae were colonized in 15 citrus trees, 6-16 years old, one in each; the group (B) of 15 larvae were colonized in 15 segments of citrus branches about 200 mm. long, one in each; 5 larvae were colonized in 5 small mulberry trees, and the remaining 2 larvae were colonized in 2 small willow trees, as follows:

GROUP A. Since the larvae were not picked out of the citrus trees and segments at the same time, and their sizes varied much, the method of colonizing them in the basal portions of

TABLE 2.—AVERAGE BODY-LENGTHS, LONGEVITY, AND FECUNDITY OF ADULTS IN CAGES.

Body-Length of Male in mm.	Body-Length of Female in mm.	Date of Captivity (1940)	No. of Eggs Deposited	No. of Eggs in Abdomen	Fecundity of Female	Date of Death (1940)	Longevity of Adults in Days
31		June 5				July 1	26
	35	June 6	8	10	19	July 2	26
35		June 8				July 9	31
	38	June 8	12	6	18	July 12	34
30		June 13				July 19	36
	35	June 13	3	12	15	July 23	40
34		June 12				July 8	26
	36	June 13	0	16	16	July 6	23
36		June 13				July 7	24
	40	June 14	6	13	19	July 3	19
31		June 30				July 31	31
	32	July 4	?	?	?	Aug. 4	31
34		June 30				July 31	31
	35	July 4	?	?	?	Aug. 4	31
35		June 30				July 30	30
	38	June 30	6	5	11	Aug. 5	36
30		June 28				Aug. 1	34
	37	June 30	0	6	6	July 28	28
36		July 27				Aug. 10	13
	36	July 14	4	12	16	Aug. 2	19
31		June 8				July 8	30
	24	June 8	6	2	8	July 6	28
Ave. 32	35				15 eggs		28

For studying facundity alone, 40 females were collected in the summer of 1940 and dissected. The numbers of eggs in the abdomens of the females varied from 6 to 20. Again, 10 females were dissected in the summer of 1941, and the numbers of eggs in the abdomens of the females varied from 8 to 19.

citrus trunks was modified a little. Those larvae, whose body lengths were longer than 16 mm., were colonized in "artificial burrows" (a.b.) made in the wood; while those, which were shorter than 16 mm., were colonized in "a.b." immediately under the bark, so that they could continue to feed in the green, sappy portion of the inner bark.

The smaller larvae, whose sizes varied from 5 mm. (newly hatched ones) to 16 mm. long, were 9 in number. About one month after the "colonization", the "artificial burrows" were opened and examined. Two larvae were found mouldy and decaying in the "a.b.", three had been eaten by ants (only head

capsules left), while the remaining four had survived very well, because they had grown big enough to bore into the wood and lived in a normal condition. Whenever a larva is about to moult, it usually is hard for it to adjust itself to a new environment, and the wet condition under the bark would very easily cause moulding. The gnawing of the inner portion of the bark by the larvae always causes the outer portion of it to become very thin, so thin that after being dried by the weather it would break and thus give inlets for the invasion of ants, especially the "small red ants" (a *Monomorium* sp., as determined by M. R. Smith).

The larger larvae, colonized in "a.b." in the wood, were 6 in all. About two months after "colonization", the "artificial burrows" were opened and examined. One larvae still remained in the "a.b.", without any signs of activity being shown, while the remaining five had burrowed well into the depths of the wood and could not be seen at all. That larva, remaining in the "a.b." was 26 mm. long when it was colonized; but when examined its body length had contracted to 19 mm.

After the middle of May, 1941, the citrus tree which had the larger larva colonized in it was uprooted, sawed, and split to look for the emergence of the adults. The larger larva had transformed into a pupa on May 16, 1941. Since no emergence of the adults occurred until June 26, another citrus tree was uprooted, sawed, and split, and again a pupa was found in it. Since no pupa of this species had been obtained, these two papae were preserved as specimens. The citrus trees were observed two or three times every day. On June 29, 1941, an adult was seen to enlarge a bore for emergence. But, it did not succeed in emerging, because the bore was made against the layers of Chinese hemp fibers, used for fastening the artificial burrow. Since the layers of Chinese hemp fibers were not so easy to be gnawed as the bark of the trunk, the adult was killed.

Between July 21 and August 2, 1941, four more adults emerged in succession. On August 2, the remaining three trees which had been colonized, each with a larva, in the summer of 1940, were uprooted, sawed, and split to discover the fate of the larvae. It was found that one larva had already transformed into an unhealthy pupa; one had died, and the last one was still living, although unhealthy, in the "a.b.", due to the poor condition of that tree. This last larva was again taken out from its burrow, and re-colonized in a better tree. It did not transform

into a pupa, until sometime in June, 1942, but died in a poor condition. This shows that if a larva fails to emerge as an adult in one year's time, it will die.

In short, in the *Group A,* out of 15 larvae colonized in the basal portions of the trunks of 15 citrus trees, five adults and three pupae were obtained in one year's time.

GROUP B. Since the 15 larvae of this group were also of different sizes, they were colonized in 15 segments, one in each, either in the "a.b." inside the wood or in the "a.b." under the the bark, according to their sizes. Each segment was stood in a glass jar, with a little water. These jars were, in turn, stood in earthenware dishes with water to protect the larvae from the small red ants. These are shown in the text-figure 2, a.

Since the segments very easily get too dry, for the larger larvae colonized in the "a.b." inside the wood, they also had to be replaced with fresh ones every 2 or 3 days. Although much time and care had to be spent on this group, they did not give as good results as the larvae (borers) of *Paradoxecia pieli,* Lieu, *Psacothes hilaris,* Pascoe, and several other species of Cerambycids. *The only reason lies in the fact that the larvae of this species feed in the green, sappy portion of the inner bark, over too long a period.* If they were poorly fed in their earlier larval stages they could not recover sufficiently to undergo the remaining transformations.

From this group, starting also with 15 larvae, only two larvae succeeded in transforming into adults.

The 5 larvae colonized in 5 mulberry seedlings and the 2 in 2 willow seedlings all died in 2 or 3 months, because the trunks of these seedlings available for use were not thick enough.

The results obtained from studying the life history are as follows:

1. THE EGG STAGE. From the two columns, "Eggs deposited" and "Eggs hatched", in Table 1, the length of the egg stage, that is, the incubation period, is from about one week to three weeks in June, July, and August. Whenever the room temperature is between 75 and 90 degrees F. or higher, the embryos in the egg shells develop more readily than when the room temperature falls below 75 degrees F.

The First Weak Point in the Life-Cycle. So far as natural enemies are concerned, the egg stage is the easiest to be attacked by ants, because whenever a cut is made on the bark of a citrus

trunk, a little sap oozes out. This oozing attracts the ants which may be able to reach the eggs.

2. THE LARVAL STAGE. The legless larva is about 5 mm. long when first hatched in June, July or August (the summer months). It feeds at first in the green, sappy portion of the inner bark of the basal portion of the trunk of a citrus tree for about 2 months and then begins to bore into the wood. The rate of growth is not uniform. One larva may grow much faster than another. For example: The six larvae, hatched from the eggs deposited under the bark in the basal portion (about 2 inches long) of the trunk of a *Citrus tangerina* in the same cage between June 13 and 20, 1939, measured, respectively, 13, 18, 27, 32, 39 and 40 mm. in length on October 11, 1939, when they were picked out of the basal portion of the trunk and of the root. The larvae hatched in the summer of 1940 showed similar variation.

The larvae, picked out of the wood through sawing and splitting, were usually larger. Their body lengths were always longer than 16 mm. and a few may be as long as 17, 18, or 19 mm. and still remain under the bark. As a rule, when a grub grows to the length of over 16 mm., its mandibles are getting strong enough for it to bore into the woody tissues, and it does so. The entrance bore into the wood made by any of the grubs is shown in the text-figure 3, b.

While the grubs still remain under the bark, the careful paring away of the dry outer bark will disclose them, surrounded by packed masses of wood-dust, in their half-formed galleries which groove both the bark and the sap-wood. This deprivation of the 6 citrus trunks of their bark is fatal to the trees (text-figure 3, b).

The grubs burrow irregularly inside the wood, sometimes upward or downward, and sometimes right or left. That the burrows are limited to the roots and the basal portions of the citrus trunks is shown by the two small citrus trees in the text-figure 3, a and c. The external view of the damage done by the grubs of this species can be seen from the text-figure 3, b, d and e; and figure 4, d and e. The total length of the burrow made in the wood by any one of the grubs throughout its larval stage is about one and one-half feet, as shown in the burrows made by many larvae. Though the burrows made by the grubs are not very long; they are fatal to the citrus trees.

Self Protection. The burrows are irregular in form; some

broad and some shallow, but the cross-sections of the burrows are always oval in shape. Each burrow has a few openings for the exudation of frass, and probably also in preparation of an exit. For self-protection, the openings and except for that portion which the grub occupies the burrow is always filled up with wood fibers and wood dust (see text-figure 3, f). Therefore, the grub is *perfectly safe* in the depth of the wood, where no attacks by either man or ants can reach it, unless the tree is uprooted, sawed, and split.

A grub, hatched in the middle of June, would enter the wood about the middle of August of the same year. In the wood, it continues to burrow until it grows to about 40 mm. long. In the first part of November, when the temperature (in room) falls to about 55 degrees F., it begins to prepare for hibernation (text-figure 3, f). Some grubs, which hatched later and entered the wood still later, continued to burrow in the wood, sometimes until December. When the temperature (in room) falls to about 50 degrees F., they begin to resume their activities inside the wood. When one has completed its growth in the spring and is about to pupate, it excavates a pupal chamber like a "dead-lane" in the same way as for hibernation, and plugs the entrance with wood fibers and wood dust, which are packed so tightly (probably with some sort of secretion from their mouths) that they are not easy to remove even with a pair of forceps. While the grubs are feeding and burrowing under the bark and inside the wood throughout their laval stage, they do not often make openings and they exude the wood dust and frass only occasionally, therefore, their destructive activities are very apt to be overlooked.

The Second Weak Point in the Life Cycle. Fortunately, there is in its life cycle, another weak point to the attacks of man. While the grubs are burrowing under the bark during the first two months, they can be killed very easily by mechanical methods (see under "Methods of Control").

The Third Weak Point in the Life Cycle. The larvae of this species are carnivorous and canabalistic, one always killing the other whenever two of them meet.

While the larva is living under the bark and inside the wood, it undergoes several moults (the exact number of which cannot be given now, but must be checked again sometime in the future). A larvae is always active, except before each moult, when it lies quiescent for a few days, corresponding to the "sleeps" of

a silkworm. After it has cast off its last larval skin, it becomes a quiescent pupa. The larval stage lasts for about 10 months.

3. THE PUPAL STAGE, INCLUDING THE PRE-ADULT STAGE. The pupa is creamy white and quiescent at first. It moves the tip of its abdomen very often while it is growing darker and darker in color. Before it is going to cast away its pupal skin to transform into a pre-adult, it becomes quiescent again. The pre-adult is also quiescent at the beginning of its transformation. It takes a week or two to reach maturity and begin its activity by scratching away the wood dust and wood fibers at the entrance of the pupal chamber and enlarging an old opening into a somewhat circular one for its emergence. This stage lasts for about one and one-half months.

4. THE ADULT STAGE. As soon as an adult has emerged, it flies away to a citrus tree and feeds on the petioles of leaves and the bark of twigs. They are very active under sunshine, flying here and there. When resting on the bark of twigs, covered by thick foliage above, heavy rains cannot knock them from the trees.

They are positively chemotropic to a spray of citrus leaves placed in the wire-gauzed cage with them, immediately coming to eat it. But if a spray of mulberry or willow leaves is substituted, they never touch it.

If a male and a female are kept together in a cage, they can be seen to touch each other with their antennae. But, if an extra male or female is added to the cage, fights are sure to occur. As a result, they are often seen with their legs and antennae broken away.

There are several points in the adult stage which may be made clear in the following paragraphs:

a. *The Emergence of the Adults.* The adults were seen to emerge on sunny days, in the early morning or in the middle of the day, but never in twilight or darkness, nor on rainy days.

b. *The Occurrence of the Adults.* They occur from the last part of May to the first part of August, but more abundant in June and July.

c. *Mating of the Adults.* They mate once or twice nearly every day. Each mating may last about one hour.

d. *Oviposition.* The females do not oviposit soon after mating. The pre-oviposition period is rather long, about 1-2 weeks. Before ovipositing, the female makes a T-shaped slit on the bark in the basal portion of a citrus trunk with two cuts

by means of its mandibles, and then deposits one egg in the slit under the bark. A female oviposits about ten eggs during its life.

e. *Longevity of the Adults.* The average number of days, the adults, collected and reared in cages in the summer of 1940, lived, was 28 days. The two adults lived for 30 and 28 days respectively. The adults which emerged in the summer of 1941, also lived for 25 days to 38 days.

f. *Fecundity.* Fecundity should include the number of eggs left in its abdomen. The average number of eggs each female, collected and reared in the cages in the summer of 1940, deposited and left in its abdomen is 15, and that of one female was 8. (See Table 2.)

In the opinion of the writer, the number of eggs each female can reproduce depends upon the size of its body. For example: one female, with a body length of 24 mm., laid 6 eggs and carried 2 when dissected, that is 8.

Therefore, the fecundity of females may be considered as varying from 8 to 20, or a little more than 20.

5. LENGTH OF LIFE. This species takes about one year's time to complete its life cycle. The lengths of the different stages of this species are shown in Table 3.

6. HOST PLANTS. The larvae have been collected from the roots and the bases of the trunks of (i) *Citrus sinensis,* Osbeck, (ii) *C. tangerina,* Tanaka, (iii) *C. limon.* Burn var. *Eureka,* (iv) *C. grandis,* Osbeck, (v) *Salix babylenica,* L., (vi) *Pyrus malus,* L.; and also from the upper portion of the trunks of (vii) *Fraxinus americana,* Linn., and (viii) *Pinus masseniana.*

The adults have been collected from citrus trees (i-iv) and big willow trees, (v); but not from apple trees (vi). The larvae, collected from the roots and bases of trunks of apple trees, are still being reared in our laboratory, to see what sort of adults will emerge next year.

The larva, collected from the crotch between the trunk and a thick branch of an ash tree (*F. americana,* L.) and that picked out of a piece of pine firewood, (*Pinus masseniana*) are very similar to those of this species; but since the parts attacked by them are quite different from those by the larvae of the citrus species, their identity remains to be determined.

The adults have never been seen to do any damage to trees other than the leaves, petioles, and bark of citrus trees. From the facts mentioned in the above three paragraphs, the host

TABLE 3.—SHOWING THE LENGTHS OF THE DIFFERENT STAGES OF *Melanauster chinensis* Forster.

Date of Egg Deposition	Egg Stage	Larval Stage (Including Hibernation)	Pupal Stage (Including Pre-Adult Stage)	Date of Adult Emergence	Adult Stage
	1 to 3 months	1 to 10 months	1 and ½ months		about one month
Egg depos. in *C. tang.* June 13-20, 1939	June 13-20 to June 25-July 4, 1939	June 25-July 4 1939, to April 22, 1940	April 23-June 7, 1940	June 8, 1940 (female)	June 8-July 6, 1940 28 days
Egg depos. in *C. tang.* June 13-20, 1939	June 13-20 to June 25, July 4, 1939	June 25-July 4 1939, to April 19, 1940	April 20-June 7, 1940	June 8, 1940 (male)	June 8, July 8, 1940 30 days
Egg depos. in *C. sinen.* June 10-July 2, 1940				May 30, 1941 (male)	Preserved after emergence
Egg depos. in *C. tang.* June 26, 1940	June 26-July 18, 1940	July 18, 1940 to May 1, 1941	May 2, 1941 to June 16, 1941	June 17, 1941 (male)	June 17-July 13, 1941 26 days

plants of this species are (i) *Citrus sinensis*, (ii) *C. tangerina*, (iii) *C. limon.*, (iv) *C. grandis*, and (v) *Salix babylenica* and most probably (vi) *Pyrus malus*, L. According to the literature, it also attacks *Litchi sinensis* Sonn. and "Kukmuk" (*Broussonetia papyrifera*, Vent.)

7. NATURAL ENEMY. This species has been observed to not have any enemy other than ants and another larva of its own species burrowing.

8. DISTRIBUTION. This species is widely distributed in Eastern Asia: China—Kwangtung Prov.—Swatew, Chae-chow-fu, Hainan Island, etc.; Fukien Prov.—Foo-chow, Chang-chow, Formosa, etc.; Szechuen Prov.—Kin-tan (Chae-chia-tu); Nantsong; Kiang-tsing (Wu-chiu-too, Shien-feng-chang, etc.); Hwayang (Lion Hill, Dong-chia-shan, Kao-tien-tzu, etc.); Sikeng Prov.—Pae-shing; Kwang-si Prov.—Hong-shan; Chekiang Prov. —Shanghai, Soo-chow; Hopela Prov.—Suan-hua-fu; Shensi Prov.—Central part; Hupela Prov.; Kiang-si Prov.—Southeastern part; Riu-Kiu Islands; Korea; Japan.

CONTROL

Before control measures can be made clear, the writer wishes to call the attention of her readers to the facts that (1) the *larval stage* of most species of insects, whether a leaf eater or a wood borer, *is the stage that does the damage,* while the adults may or may not be; and (2) the larvae of leaf eating insects, which do damage to the foliage of trees, are usually exposed, while those of wood-boring insects, especially those of Cerambycids, almost always live *concealed in the depths of wood with very good means of self-protection.* So it is obvious that the common methods of control for combating leaf-eating insects can seldom be applicable for the control of wood-borers.

The larvae of leaf-eating insects can be controlled by collecting them in large quantities or by exposing them to insecticides, such as stomach poisons or contact poisons, by means of sprayers or dusters; while with the larvae of wood-boring insects, they cannot easily be collected or killed with insecticides. Sprayers and dusters are almost useless things for entomologists against wood-borers. Therefore, how to control this species of citrus-root-cerambycid (*Melanauster chinensis,* Forster), both the larvae and adults of which do damage to the trees, is not as simple a question as thought by some entomologists in the East, but a rather difficult problem to be solved.

Since citrus are very valuable fruits and the raising of them is an important industry, the control of this fatal pest to citrus trees is of great importance. From the very beginning, the writer had planned to find out the weak point or points in its life cycle. Several months later, after she had observed the food-habits, damage, mating, and oviposition of the adults, and hatching and tunneling under the bark, of the larvae, she began to be able to set a few questions as an outline for her plan of control. The questions are:

(1) How to kill the adults so that they cannot do damage to young citrus trees?
(2) How to prevent the adults from depositing eggs under bark of basal portions of citrus trunks? and
(3) How to kill the larvae before they bore into the wood?

As mentioned above, the study of its life history has been repeated twice. Through her two years' study, it is very fortunate that the writer was able to find out the most important weak point in its life cycle. This is *the deposition of eggs under bark*

and the tunnelling of the young larvae under bark for a period of about two months. The deposition of eggs under bark can be discovered by any untrained workman if he is able to make some observations; but the *tunnelling of the young larvae under the bark is the most difficult part to study* and had never been studied before by any entomologist either in China or in the Japanese Islands. This is shown by the fact that the methods of control of this species suggested by some entomologists in the East, such as Sho Takahashi and some others, are simply fictional, without being based on a study of life history.

For studying this particular point, i.e., *the period of young larval stage under bark,* the writer often visited the citrus orchards in the Hwayang suburbs in the summer and autumn months (June-November) of 1939 and 1940, in searching for the larvae.

In every citrus orchard she visited, she looked for the exudation of frass and wood dust in the citrus trunks, from top to base. When any exudation was found, she taught the workman to chisel little by little and trace the groove further and further. All the larvae found on the trunks belonged to another species; all those found in the basal portions of the trees belonged to this species.

The larvae found under bark in the basal portions of citrus trunks were all smaller ones (5-16 mm. long) and those found in the trunk were all larger. When any larva still remained under the bark it was easy to find. By chiselling and paring of the bark, very soon the half-formed gallery appeared and as paring went on further and masses of packed wood dust had to be removed, finally the entire half-formed gallery began to be exposed, as shown in the text-figure 3, b., and the larva could be extracted uninjured. The half-formed gallery is not easily described. It is not straight but extends partly upward and partly downward, partly broad and partly narrow, and branching this way and that, and surrounding the base of the tree in a spiral direction. A young citrus tree, say about 5 or 6 years old, is bound to die after the bark of the basal portion of it is thus destroyed, by even one larva of this species. (See text-figure 3, b.)

If the larva had already bored into the wood, difficulties began. If the burrow in the wood was still short and very near to the surface, chiselling little by little could sometimes enable it to be hurt or unhurt. If the burrow was deeper, or so deep

that it had already gone down to the root or even rootlets, it was hopelessly lost, unless the tree could be uprooted, sawed, and split.

All the living ones, brought back to the laboratory, were colonized, either in segments of branches or in the basal portions of the citrus trees, one in a piece to see how long they would stay under bark. The results obtained from these collections were compared with those obtained by studying the life history of this species in cages, and were found to agree very well. Finally, it was established clearly the *period of the young larval stage under bark is about two months.*

Based on this discovery, we can be sure that the earliest hatched larvae (in June) would bore into the wood in August; and those hatched last (in August) would bore into the wood in October. To prevent the larvae from doing much harm to the basal portions of citrus trunks, they should be killed as early as possible. But, when they are very small, it is rather difficult for inexperienced workers to find them. Therefore, the writer wishes to suggest that *the best period for killing the larvae, before they bore into the wood, is from the first part of July to the first part of October.* This is, indeed, the key to the whole situation, because it not only answers the third question in the outline (page 90), but also helps to solve the first and second questions indirectly, as discussed more fully under the sub-heading 2, Methods of Control.

Before the key to the whole situation had been acquired, the following preliminary tests were made, one after the other, (i) trying to kill the larvae (borers) in the wood, (ii) testing the efforts to kill the adults with poisons, and (iii) trying to prevent the females from depositing eggs under the bark.

1. TRYING TO KILL THE LARVAE IN THE WOOD

Many citrus growers in Hwa-yang, Kin-tan, and Kiang-tsing believe that heads of matches placed in the bores made by the larvae can kill them. Some entomologists of the Japanese Islands also suggested a similar means for killing the larvae. Of course, the writer wished to try this method first.

On November 15, 1939, some frass and wood dust were seen piled up at a small bore on a thick branch of a lemon tree in the orchard on the college grounds. From the color and the condition of the frass and wood dust, it was evident that they had been exuded inside of 2 or 3 days. This lemon tree has three very

low branches. One particular branch made an acute angle with the ground, and the crotch was only about 2 inches from the ground.

Before applying any insecticide, the frass and wood dust was first cleaned from the bore and the portion of the burrow extending downward was explored with a pair of forceps and cleaned up also. Then a brass hook was thrust into the burrow expecting to hook out a borer from it. But, no borer was found. So it was thought that the borer may have burrowed much further down. The lower end of the portion of the burrow extending upward when explored with the tips of a pair of strong forceps, was like a sold mass, so this portion of the burrow was overlooked.

After the bore and the descending portion of the burrow had been cleaned up, 5 puffs of freshly prepared pyrethrum powder were blown into this portion with a copper blower, plugged tightly with cotton, and sealed with cold wax.

On December 2, 1939, this branch was sawed off, split, and examined. As the result, a living borer of this species, whose body length was about 25 mm. was found within the ascending portion of the burrow, which was separated from the lower portion by a plug of wood dust, which was pressed so tightly with a secretion (probably from its mouth) that a pair of strong forceps could not easily pick it away. The length of this ascending portion of the burrow was about 85 mm., that of the descending portion about 50 mm. and that of the plug about 70 mm. The plug was made so air-tight that it was believed that no odor of the pyrethrum powder could reach the borer. *This method of self-protection* by the borer of this species (text-figure 3, f) has shown very clearly that *this sort of attempt to kill the borers is simply a failure.*

2. ATTEMPTS AT KILLING THE ADULTS WITH POISONS

On June 1, 1940, 2 pairs of adults were placed in 2 small wire cages, each of which was supplied with 2 pieces of citrus segments, whitewashed with quick-lime paste and a spray of citrus leaves daily. They were observed several times daily. It was found that the adults ate the leaves and bark of the citrus sprays every day, but never touched the whitewashed segments. After 3 days, no more citrus sprays were supplied; but the adults still never touched the whitewashed segments.

On June 6, a fresh citrus-branch-segment was whitewashed with the same quick-lime paste. When it was dry enough, an

adult was held between the thumb and the index finger at the bases of its elytra, and pressed gently against the whitewashed segment for about 5 minutes. The adult began to open and shut its mandibles so often that some of the lime paste was taken into its mouth. After 5 minutes, it was returned to the cage, and supplied with a spray of citrus leaves. This was repeated with each of the 4 adults. Three adults died in 4 days and 1 died in 6 days.

The same trials were repeated with another 2 pairs of adults in exactly the same way except that the composition of the whitewash was a mixture of quick-lime and sublimed sulfur. The adults all died in 2-3 days.

The same trials were repeated with another 2 pairs of adults in exactly the same way, except that the compositions of the whitewash was a mixture of quick-lime and calcium arsenite. The beetles all died in 2-3 days.

The same trials were repeated with another 2 pairs of adults in exactly the same way, except that the composition of the whitewash was a mixture of quick-lime and arsenious oxide. The beetles all died in 2 days.

From the results obtained here (Test II), it can be asserted that after the basal portion of any citrus trunk has been whitewashed with any of the 4 kinds of paste, if any adult should be "bold" enough to gnaw at the bark to make an incision, it will surely die very soon.

3. PREVENTING THE FEMALES FROM DEPOSITING EGGS UNDER BARK

In a cage with a pair of adults, the citrus-branch-segment, whitewashed with simple lime paste, was not touched by the female beetle, even though it had deposited 6 eggs in the *C. tang.* and again 6 eggs in another citrus segment.

In the cage of the Fifth pair of adults (see Table 1), the trunk of the *C. grand.* was whitewashed with simple lime paste to a height of 20 inches. For the first 16 days, the female did not deposit even a single egg in it. But, after heavy rains on June 27, 29, 30, and July 1, which washed away the paste at some places near the lower portion of the trunk, 3 incisions were found and 3 eggs had been deposited in them.

In the cage of another pair of adults, the trunk of the *C. sinen* was whitewashed with lime-sulfur paste to a height of 20 inches and that of a *C. tang.* with lime-calcium-arsenate to

a height of 18 inches. For 31 days, not a single incision was made on either of the two trees, although 15 eggs in toto had been deposited in 5 citrus segments.

In the cage of another pair of adults, the trunk of the *C. tang.* was whitewashed with lime-arsenious-oxide paste to a height of 8 inches. For 36 days, not a single incision was found on the trunk, although 2 eggs had been deposited in willow segments, three in a mulberry segment and 1 in the trunk of the *C. grand.*

These tests have shown clearly that (1) after the borers have once entered the wood, if their whereabouts are *definitely known* they can be killed by hooking out without any need of insecticides; but if their whereabout are *not definitely known their method of self-protection can foil any attempt at killing them with insecticides;* (2) the four kinds of whitewash pastes are all offensive to the chemical sense-organ of the adults, and of the four the lime paste seems the weakest and the lime-arsenious-oxide the strongest; and (3) whitewashing of the basal portions of citrus trunks can protect them from attempts of the females to cut slits for the deposition of eggs.

While the tests for controlling this species were being carried along in her laboratory and on the college campus, the whitewashing of (1) a portion of her own citrus trees on the campus, (2) those in the Lion-Hill citrus orchard, and (3) those in the seven citrus orchards of private citrus growers at Sze-tzu-ling in Hwa-yang suburbs was being carried forward. In addition, the control tests for the citrus trunk cerambycids were also made in the same seasons. Therefore, her work in the summer and autumn of 1940 was the heaviest of all other years. Moreover, it must be remembered that the alarms of air-raids and cruel bombings from our beastial enemy were the most numerous in Chengtu from May to November, 1940. It was fortunate that the writer was not killed by those bombings. She is very happy that she is now able to write a paper on the results of her study for the benefit of her own country people who raise citrus fruits, and at the same time, she wishes that it may be of a little use to our American friends who cultivate even more citrus fruit than we do.

Since chemicals from abroad were not available during our war of resistance, the writer made up her mind to try all local materials, such as quick lime, sulfur, calcium arsenate, and arsenious oxide for her tests. Since lime alone seemed not strong

enough, she chose the two formulae: (1) quick-lime and sulfur, and (2) quick-lime and arsenious oxide for all the following practical experiments:

EXPERIMENT I.

Whitewashing of Lieu's Citrus Trees. For the use of "colonizing" the borers of different species of citrus cerambycids, the writer bought some two hundred citrus trees of different ages (2-3 years, 5-6 years, 11-12 years, and 15-16 years) within three years, 1939-1941, and had them planted on several small pieces of ground on the college campus.

On June 9, 1940, she chose the citrus trees on a small piece of ground for tests. There were 14 in all, some were 11-12 years old. She had the tree trunks completely whitewashed with the formula for controlling the species first. When the whitewash paste had dried she had the basal portions of 7 citrus trunks whitewashed with the *quick-lime and sulfur paste* and another 7 with the *quick-lime and arsenious oxide paste* (text-figure 4, a).

Results. The bark of the basal portions of the 7 citrus trunks, whitewashed with the formula (2), *quick-lime and arsenious oxide paste,* looked somewhat dry; while those with the formula (1), *quick-lime and sulful paste,* were uninjured, as examined two weeks later.

EXPERIMENT II.

Whitewashing of the Citrus Trees in the Lion Hill Orchard. In this orchard, there were some three to four hundred citrus trees of 20-30 years of age. The writer chose 50 of them for experiments. On June 15, 1940, the trees were first whitewashed with the formula for controlling *Melanauster chinensis,* Forster. When the whitewash was dry, she had the basal portions of the trees whitewashed with the formula of *quick-lime and sulfur paste.*

Results. These citrus trees were examined 2 weeks later, and it was found that the basal portions of these citrus trunks whitewashed with the *quick-lime and sulfur paste* were normal, and not a single incision was found; while the trees, not whitewashed, in the same piece of ground had many incisions made at their basal portion.

EXPERIMENT III.

Whitewashing of Citrus Trees at Sze-tzu-ling in Hwa-yang

Suburbs. Sze-tzu-ling is the citrus center of Hwa-yang-hsien and is about 20 lis (equal to 6-7 miles) from this college. There are many private citrus orchards, large and small. Although the owners suffered some losses from these cerambycid borers, they had never realized the causes of the damage. Moreover, they were not familiar with the manner of whitewashing. Through many attempts the writer obtained permission of 7 owners, to use 10 citrus trees in each orchard for experiments. These seven orchards were not near together. The whitewashes were applied there during the first part of July 1940. Since the whitewash for combating this *Melanauster chinensis*, Forster, is comparatively much easier, two more boys employed besides the workman Wang-soo-yuin were sufficient for the work to be done.

In each orchard, the 10 healthy citrus trees were evenly divided by the writer, into 2 groups, A and B. They were cleaned of any dirt and whitewashed by the boys.

The formulae used for whitewashing in the seven orchards were of two kinds, viz: (1) *quick-lime and sulfur*, and (2) *quick-lime and arsenious oxide.* The ingredients for each formula were all weighed by the writer in her laboratory, and the mixing of the ingredients in the field was also done by her own hands.

The trees in group A were treated with the quick-lime and sub-limed sulfur; those in group B with quick-lime and arsenious oxide. In each case it was applied to a height of about 33 cms. or one foot.

Results. From the first part of August to the mid part of October, 1940, three inspection trips were made to each of the seven orchards. Each time an inspection was made in an orchard, 5 healthy and unwhitewashed trees, in addition to the 5 trees of Group A and the 5 trees of Group B, were examined for egg incisions at their basal portions. Altogether, 35 healthy and unwhitewashed citrus trees, 35 trees of Group A, and 35 trees of Group B were examined. The results were:

35 Trees of	Total No. of Egg Slits at the Basal Portions	Condition of Bark at the Basal Portions
Group A	0	Normal
Group B	0	Slightly dry appearance
Healthy and unwhitewashed	53	Poor

After having made a careful and continuous study of its biology and control for about 2 years, accompanied by a series of tests and practical experiments, the writer began to be able to give the methods of control of this species, *Melanauster chinensis,* Forster, as follows:

METHODS OF CONTROL. The methods of control include 3 steps; 1, killing of the adults; 2, killing of the eggs and the larvae while under bark; and 3, whitewashing of the basal portions of trunks.

1. KILLING OF THE ADULTS

Period of Collecting. Examine the basal portions of the trunks and at the summer shoots of citrus trees, and kill all seen.

2. DESTROYING OF THE EGGS AND THE LARVAE WHILE UNDER BARK.

Two or three times each month from the first part of July to the first part of October of each year.

Examine the basal portions of the trunks (up to a height of 1 foot) for egg slits and exudations of wood dust and frass. If there is any egg slit, pressing on it with the thumb should smash the egg. If there is any exudation of wood dust or frass, pare off the bark little by little to look for the young larva and kill it. If this is thoroughly done, there will be no adults at all the following year, and need to kill and prevent from depositing eggs.

3. WHITEWASHING OF THE BASAL PORTIONS OF CITRUS TRUNKS

Period for Application. Choose a sunny day during the first part of June.

Formula Chosen:	Quick-lime	10 catties
	Sub-limed sulfur	½ catty
	Water	40 catties

Slake the lime in a vessel, large enough to contain the whole mixture, with about 3 catties of water (preferably hot water) until it has all slaked. If it is too thick, add another 3 catties of water. Then add the sulfur little by little, while the lime is boiling. Stir the solution slowly and evenly until it is well mixed. Finally, add water to make the entire weight of the mixture 40 catties, and continue to stir. This mixture is sufficient for whitewashing 50-60 citrus trees of about 20-30 years of age.

Method of Application. Before whitewashing, the basal portions of citrus trunks should be swept clean, examined first to make sure that not a single egg or larva is allowed to remain there, and the bases should be cleaned of mud and swept clean also. When the whitewash solution is ready apply it to about one foot of the basal portions with a soft brush made of fibers of the plant *Abutilon theophrasti,* Medic., as shown in the text-figure 4, c. When the whitewash has dried the bases should be covered up again with the mud which had been removed before. This coating will remain for about two months, protecting the basal portions from deposition. These trees should be inspected once a month. In short, it is suggested that any one who has 1 or 2 hundred citrus trees should take steps 1 and 2; and any one who has more trees or a larger orchard, may choose to take steps 1 and 3. Our Government should do two things to help the people to annihilate this citrus pest.

First decree that any citrus trees badly affected by the larvae of this species should be uprooted, sawed, and split, in order to kill all the grubs, pupae, and pre-adults in them; and as early as possible, that an organization for the inspection of any citrus trees, imported from any other localities, should be established.

As soon as the methods of control had been found, a booklet, "*Melanauster chinensis,* Forster (Citrus root cerambycid)", was written in Chinese by the writer for distribution to Chinese citrus growers and published in April, 1941, by the Agricultural Production Promotion Commission, Ministry of Agriculture and Forestry.

SUMMARY

1. This species of citrus root cerambycids, *Melanauster chinensis,* Forster, attacks citrus trees in both its adult and larval stages. The adult eats the leaves, petioles, and bark of twigs and branches, and of the trunks if the trees are very young. The larva, immediately after hatching, feeds for about two months in the green, sappy portion of the inner bark of the basal portions of the trunks of citrus. When it has grown to a length of 16 mm. to 20 mm., it begins to bore into the wood, and seriously mines the trunk, the root, and the rootlets. One larva of this species is able to cause the death of a citrus tree up to an age of about 5-6 years.

2. It has one generation in a year. The adults appear from the last part of May to the first part of August, but are most abundant in June and July. They mate soon after emergence

and the pre-oviposition period may last for 1-2 weeks. The females cut slits on the bark in the basal portions of citrus trunks, close to the ground, and deposit eggs in these slits. The eggs take 1-3 weeks to hatch. This species passes its egg, larval, pupal, and pre-adult stages inside the tree for 12 months, more or less, and then emerges as an adult, which lives in the open for about one month or so. A female may deposit 10 eggs, more or less.

3. While inside the wood, the larva protects itself very well in its burrow, where no insecticide can reach it.

4. The larva grooves under bark for about two months. This is the most important weak point in its life cycle.

5. Its only enemy is the ants in its egg stage. No parasite has been observed throughout its life cycle.

6. The methods of control include three steps, namely:
   A. Killing of the adults;
   B. Crushing of the eggs and the larvae under bark; and
   C. Whitewashing of the basal portions of citrus trunks.

7. Its host plants include not only all species of citrus trees but also willows, apple trees and some others.

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To le R. P. O. Piel, the Director of Musee Heude, Shanghai, and to Prof. G. P. Jung, Department of Entomology, College of Agriculture, National Chung-shan University, the writer wishes to express her hearty thanks for their foresight in helping her to continue the study of wood-borers, the importance of which nobody except them and the writer had ever foreseen in China before our war of resistance broke out on July 7, 1937.

The writer wishes to take this opportunity to express her deep appreciation and thanks to Prof. K. S. Sie and F. C. Woo for their advice and suggestions regarding the new problem, "Survey on the Citrus-Cerambycids of Szechuen and Experiments for Their Control" (p. 63), which is very important for combating these serious cerambycids, fatal to citrus trees, and which is in line with her researches since the year 1933.

Sincere acknowledgments are due to Prof. C. W. Chang, the Dean of the College of Agriculture, Nanking University, Prof. K. S. Sie, and Prof. Y. Hsuwen Tsou, the former Dean of the College of Agriculture, National Central University, for their advice and encouragements in helping her to carry on her work so far.

For carrying out experiments for the control of this species, and for spreading information of control measures to citrus growers in this country, the writer appreciates very much the financial help rendered her by Mr. H. Y. Moh, the Chairman of the Agricultural Production Promotion Commission, Ministry of Agriculture and Forestry, Prof. C. M. Chiao, the acting chairman, and Prof. F. C. Woo, the expert of the same.

In taking photos for her specimens of both the insects and affected parts, she is very thankful to Messrs. C. C. Wu and H. T. Tsing (correct spelling: Shi-tien Djin) for their kind help and high technique.

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KEY TO THE LETTERING OF THE FIGURES

A.....1st. abd. segt.
"a.b."...."artificial burrow"
amp.....ampulla
ant.....antenna
E-D.....entrance-bore
l.....lower
meso-.....mesothorax
meta-.....metathorax
oc.....ocellus
port.....portion
proth.....prothorax
upp.....upper

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CINARA OSBORNIANA nom. n.

A Correction

In the last number of the Florida Entomologist (Vol. XXVII, pp. 43-54, published January 15, 1945) I described an apparently undescribed species of aphid, giving it the name *Cinara osborni* n. sp. I have now discovered (March 5, 1945) that I inadvertently overlooked the fact that Dr. G. F. Knowlton in 1942 described another species of *Cinara* under the same specific name *osborni*. *Cinara osborni* Tissot clearly is a homonym of *Cinara osborni* Knowlton. Because my recently described species now stands without a valid name I here propose for it the new name *Cinara osborniana*.

A. N. TISSOT

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THE DAMAGE OF MELIPOTIS ACONTIOIDES TO THE ROYAL POINCIANA

J. R. WATSON

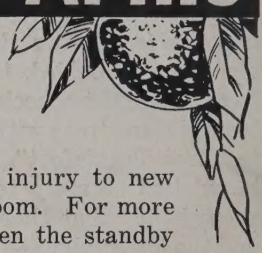
(Continued from last issue)

From the observations of Mr. Singleton at Key West, and corroborated largely by a Mr. Phillips of St. Petersburg, we can reconstruct some phases of its life history about as follows: The caterpillar is a night feeder, retiring into the ground or at least into trash around the base of the tree in the early morning, and ascending the tree again at night. If good hiding places are provided, it may not necessarily go to the ground. In an attempt to check the migrations up the tree, Mr. Singleton banded some trees with a home made decoction somewhat similar to "Tree Tanglefoot", which he placed on bands of heavy cardboard tied securely to the tree. He found when he removed these bands that there were caterpillars under both the upper and the lower edges—in other words, they had congregated there on their way down and on their way up, and found protection from light. That this was a pure light reaction was evidenced in January, 1944, by the fact that at that time the pods on the trees were cracking and opening and the caterpillars instead of retiring to the ground in the early morning, simply crawled into these pods. A box at the base of the tree also seemed to make a very acceptable place to stay during the day. It is rather peculiar that there should be any caterpillars on these trees in January when normally a Poinciana is bare of leaves. But in this case the trees had been defoliated in the late summer of 1943 and had put out fresh leaves in the late fall at a time when the tree is usually shedding its leaves. It was on these leaves that the caterpillars were feeding. That raises an interesting question: How did the caterpillars "know" that there was suitable food there? Ordinarily, under normal conditions, there would be none. Under normal conditions there, it would seem that the eggs do not hatch in January. Does the presence of these young leaves give off some substance which causes the eggs to hatch? It might seem fantastic at first glance, but evidently this same thing does happen in the case of the tent caterpillars on a wild plum. The time of leafing of a wild plum will vary considerably from year to year with the variation of weather but the eggs invariably hatch about the time the first leaves appear.

(To be continued)

"Black Leaf 40"

KILLS CITRUS APHIS



Protect the fruit and foliage from *Citrus Aphis*. Spray with "Black Leaf 40" while the foliage is young and the infestation is light. Prevent injury to new growth, especially while trees are in bloom. For more than 30 years "Black Leaf 40" has been the standby of particular growers.

ASK YOUR EXPERIMENT STATION

For many years leading authorities have endorsed "Black Leaf 40." It kills insects not only by contact (hitting) but also by fumes. When you mix "Black Leaf 40" with lime-sulphur, oil emulsion, Bordeaux or calcium arsenate, or soap, you convert nicotine sulphate into volatile nicotine with powerful "gassing" properties.

Dusting is often more convenient than spraying on vegetables. The powerful nicotine fumes are released from the dust against the various sucking insects attacking these plants.

"Black Leaf 40" may be added to other standard sprays or dusts. It is highly concentrated, economical—a little goes a long way.

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KILLS BY CONTACT AND FUMES